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Sander

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(54) **NETWORK NODE, METHOD, AND MOBILE TERMINAL FOR PROVIDING VOICE CALLS TO A MOBILE TERMINAL IN A PACKET-SWITCHED-ONLY NETWORK**

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This patent is subject to a terminal disclaimer.

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Related U.S. Application Data

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(51) **Int. Cl.**

H04M 7/00	(2006.01)
H04W 76/04	(2009.01)
H04W 68/00	(2009.01)
H04W 8/06	(2009.01)

(52) **U.S. Cl.**

CPC ***H04W 76/04*** (2013.01); ***H04W 8/06*** (2013.01); ***H04W 68/005*** (2013.01); *H04M 2207/187* (2013.01)

(58) **Field of Classification Search**

CPC H04W 68/00; H04W 76/04; H04M 7/006

See application file for complete search history.

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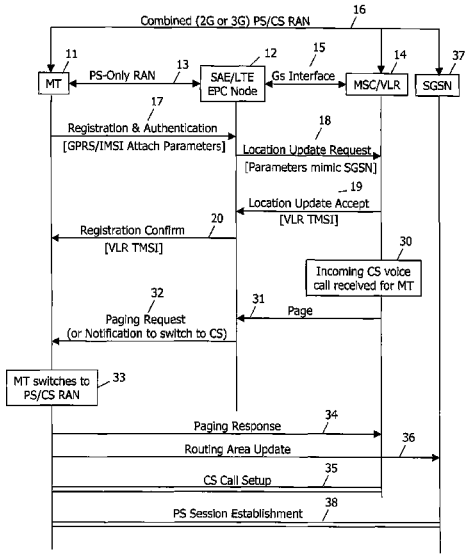
Primary Examiner — Khaled Kassim

(57) **ABSTRACT**

A network node, method, and mobile terminal for providing circuit-switched (CS) voice calls to a mobile terminal operating in a packet-switched (PS)-only network. A control node such as an EPC node in an SAE/LTE PS-only network is modified to mimic the messaging functionality of a Serving GPRS Service Node (SGSN). The EPC node is connected to an MSC/VLR in a CS network through a Gs interface. The EPC node registers the terminal with the MSC/VLR and provides a VLR TMSI to the terminal. When the MSC/VLR receives an incoming CS voice call for the terminal, the MSC/VLR notifies the EPC node, which sends a paging message to the terminal. To set up the CS voice call, the terminal sends a paging response directly to the MSC/VLR.

13 Claims, 6 Drawing Sheets



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3GPP TS 29.018 V7.2.0 (Mar. 2006); 3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; General Packet Radio Service (GPRS); Serving GPRS Support Node (SGSN)—Visitors Location Register (VLR); Gs interface layer 3 specification (Release 7).

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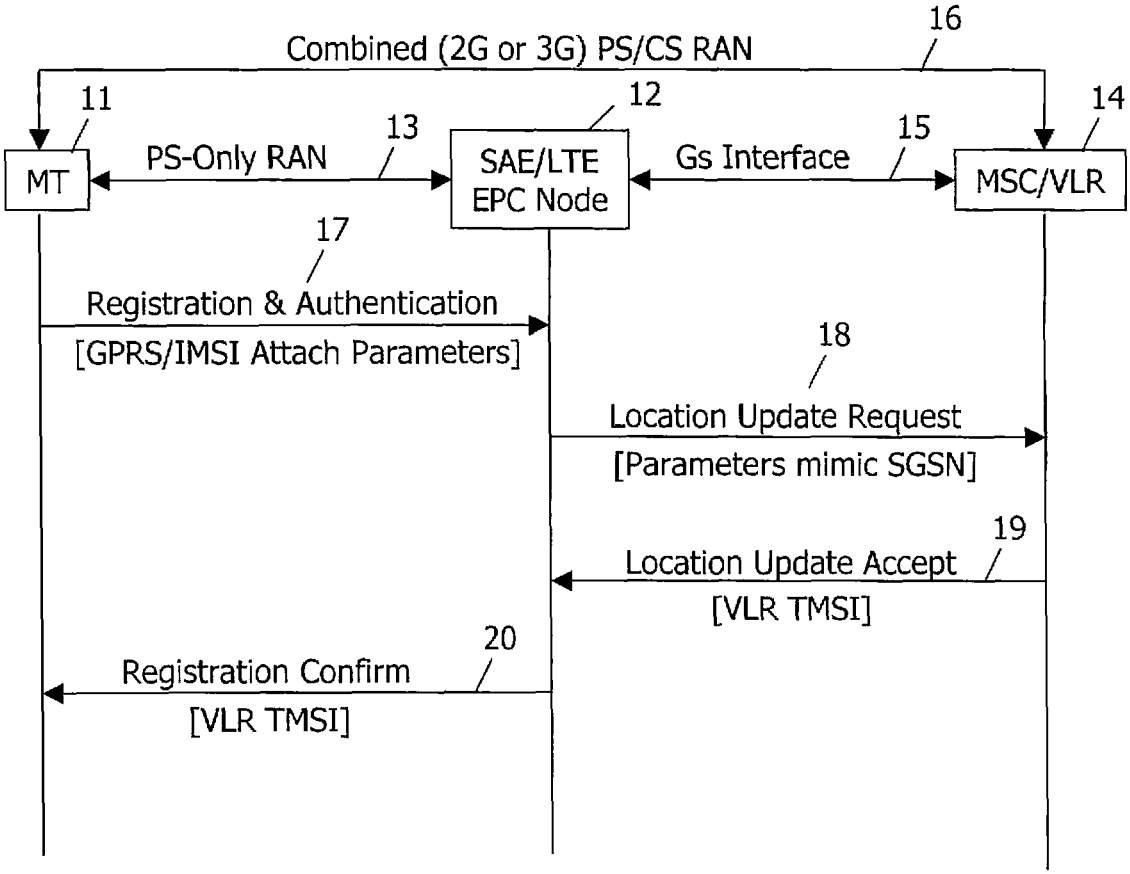
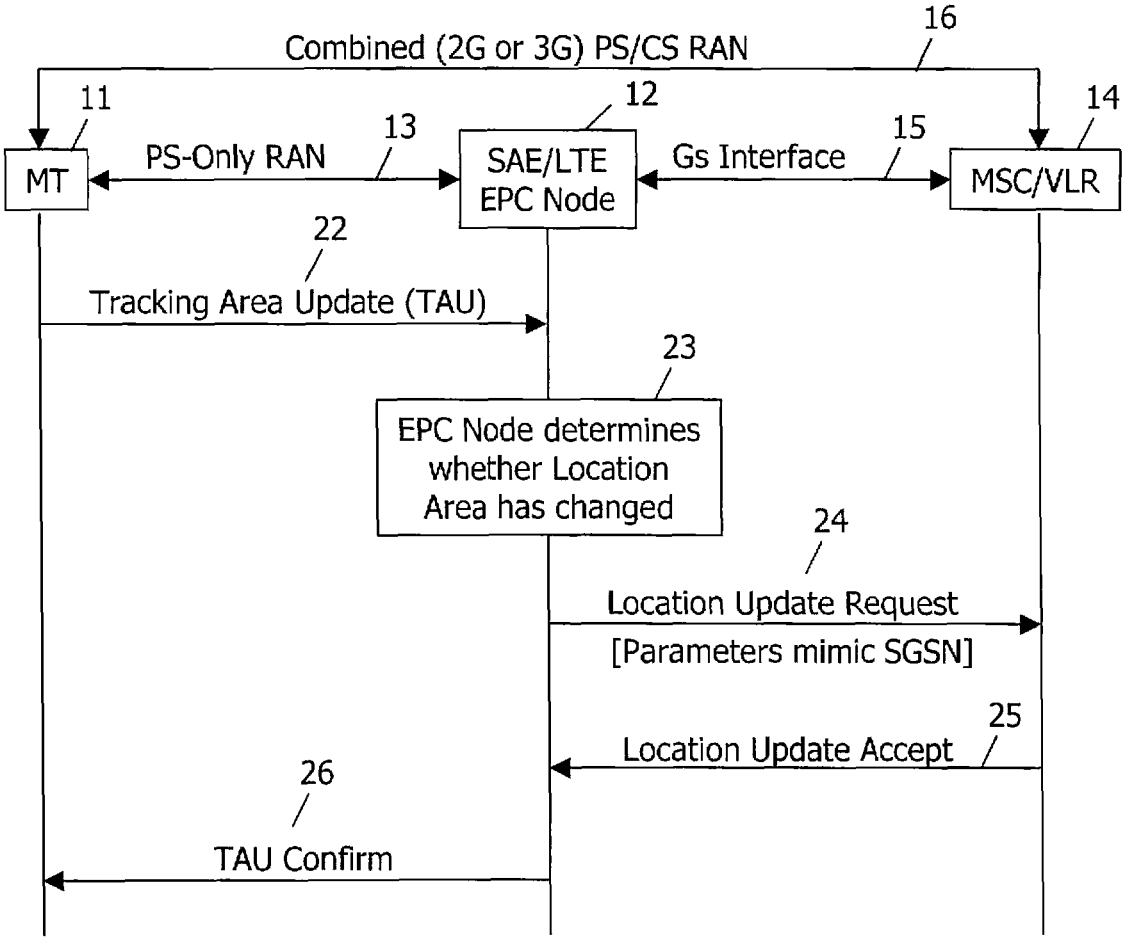

16
Combined (2G or 3G) PS/CS RAN
11
12
14
13
15
MT
PS-Only RAN
SAE/LTE
EPC Node
Gs Interface
MSC/VLR
17
Registration & Authentication
[GPRS/IMSI Attach Parameters]
18
Location Update Request
[Parameters mimic SGSN]
19
Location Update Accept
[VLR TMSI]
20
Registration Confirm
[VLR TMSI]

FIG. 1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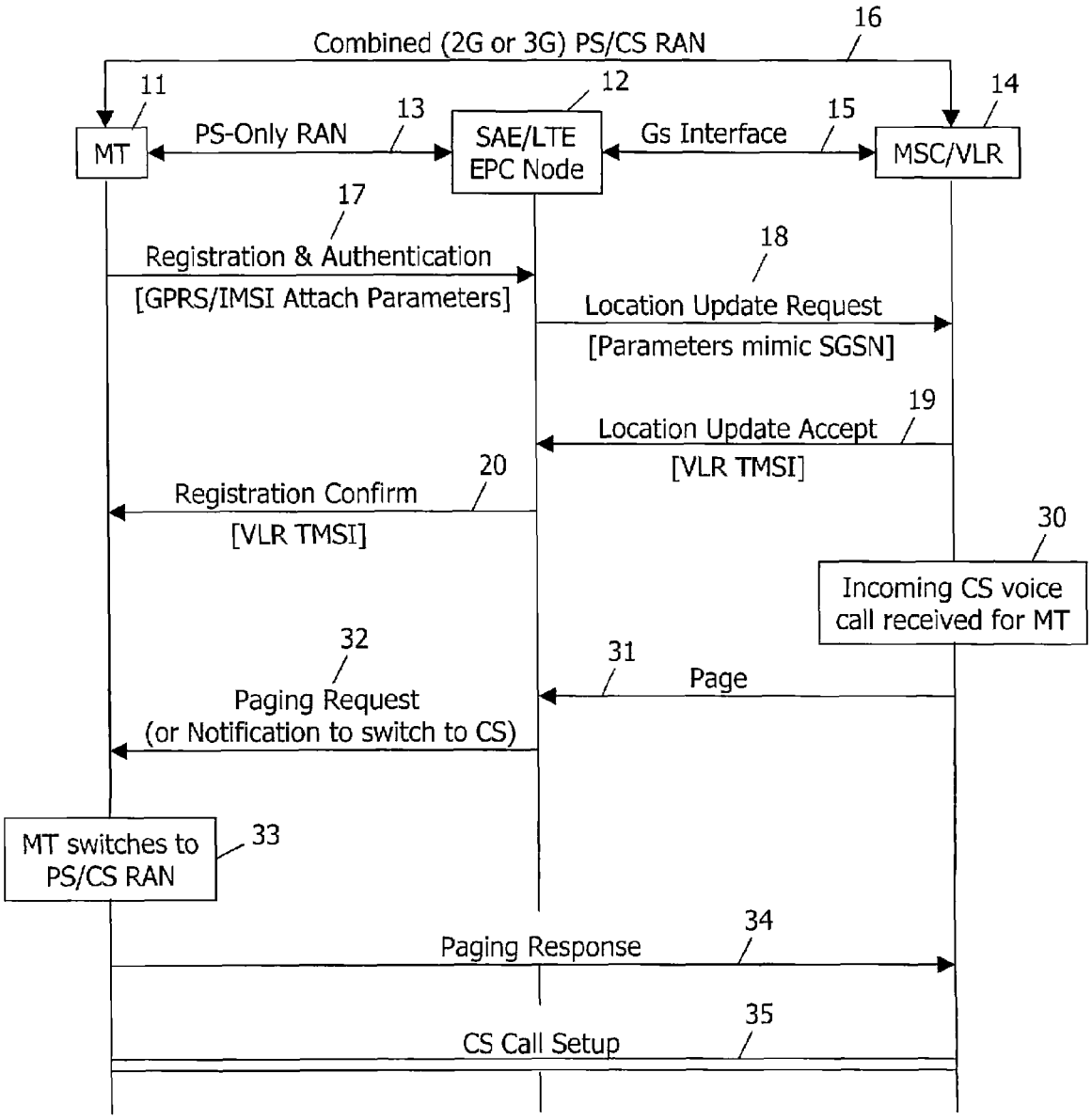
Combined (2G or 3G) PS/CS RAN
11
12
14
13
15
MT
PS-Only RAN
SAE/LTE
EPC Node
Gs Interface
MSC/VLR
22
Tracking Area Update (TAU)
23
EPC Node determines
whether Location
Area has changed
24
Location Update Request
[Parameters mimic SGSN]
25
Location Update Accept
26
TAU Confirm

FIG. 2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15
Gs Interface
MSC/VLR
17
Registration & Authentication
[GPRS/IMSI Attach Parameters]
18
Location Update Request
[Parameters mimic SGSN]
19
Location Update Accept
[VLR TMSI]
20
Registration Confirm
[VLR TMSI]
30
Incoming CS voice
call received for MT
32
Paging Request
(or Notification to switch to CS)
31
Page
MT switches to
PS/CS RAN
33
34
Paging Response
35
CS Call Setup

FIG. 3

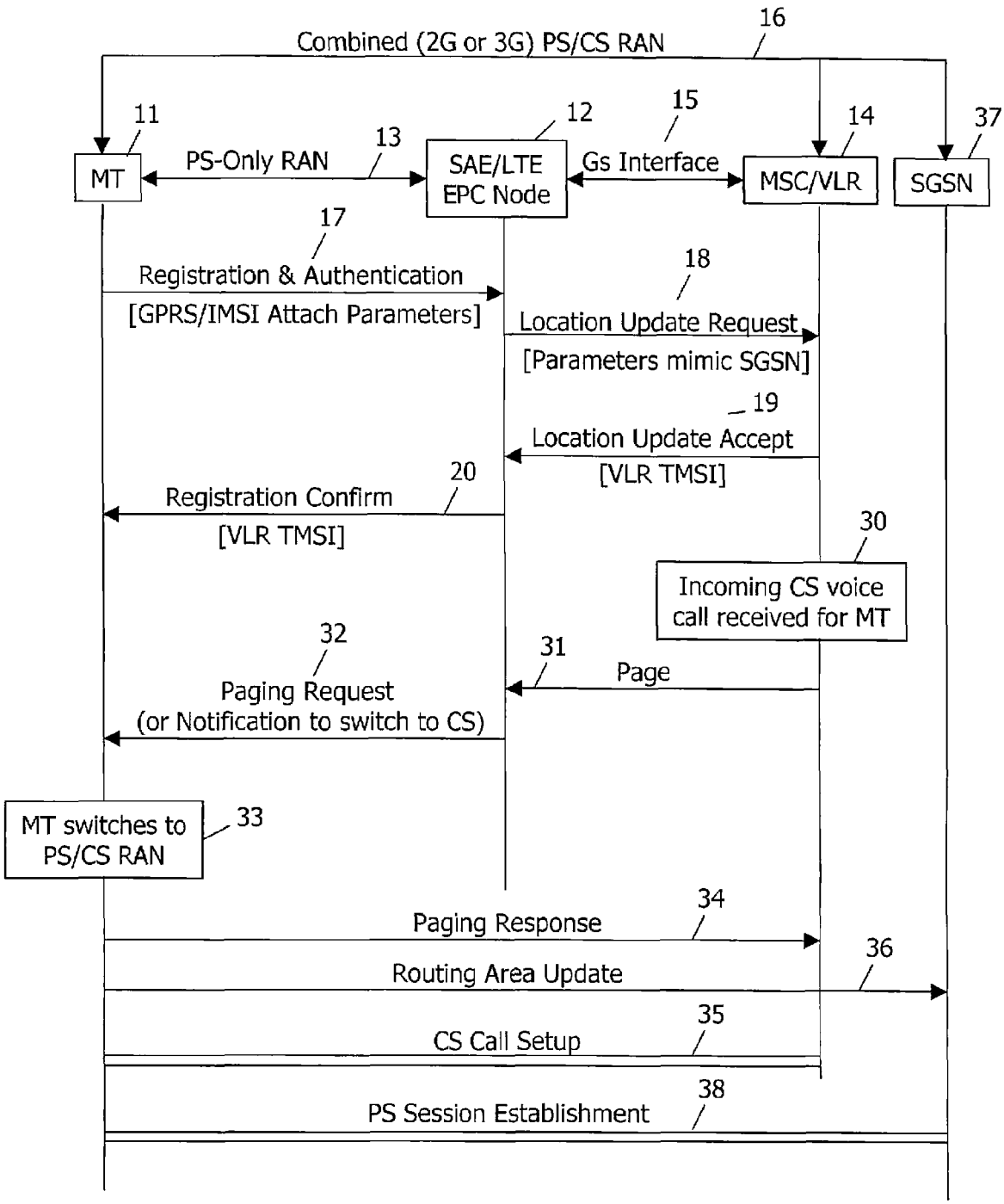
16
Combined (2G or 3G) PS/CS RAN
11
MT
13
PS-Only RAN
12
SAE/LTE
EPC Node
15
Gs Interface
14
MSC/VLR
37
SGSN
17
Registration & Authentication
[GPRS/IMSI Attach Parameters]
18
Location Update Request
[Parameters mimic SGSN]
19
Location Update Accept
[VLR TMSI]
20
Registration Confirm
[VLR TMSI]
30
Incoming CS voice
call received for MT
32
Paging Request
(or Notification to switch to CS)
31
Page
MT switches to
PS/CS RAN
33
34
Paging Response
36
Routing Area Update
35
CS Call Setup
38
PS Session Establishment

FIG. 4

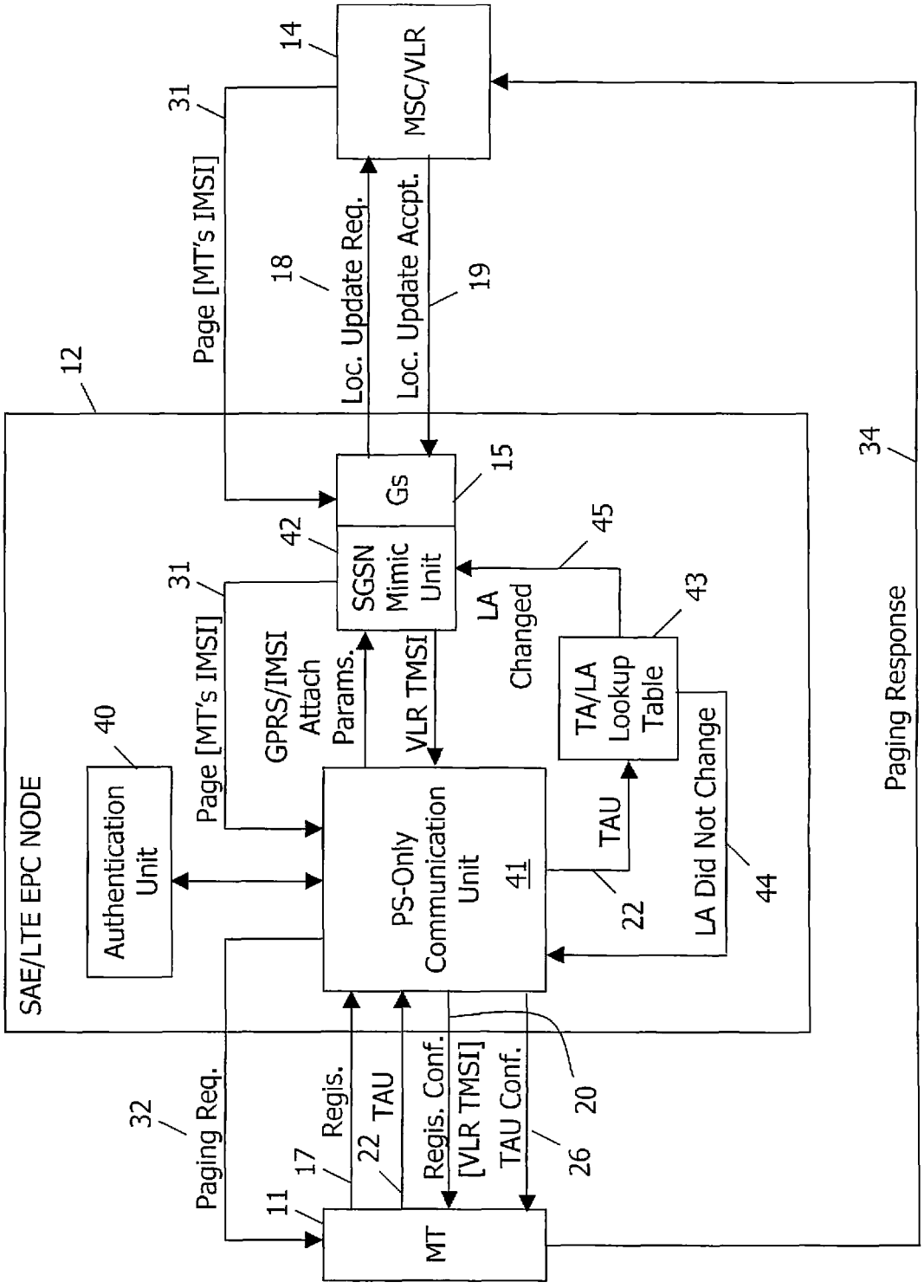
MSC/VLR
14
31
Page [MT's IMSI]
18
Loc. Update Req.
19
Loc. Update Accpt.
12
Gs
15
42
SGSN Mimic Unit
45
LA Changed
43
TA/LA Lookup Table
31
Page [MT's IMSI]
GPRS/IMSI Attach Params.
VLR TMSI
40
Authentication Unit
PS-Only Communication Unit
41
TAU
22
LA Did Not Change
44
SAE/LTE EPC NODE
34
Paging Response
32
Paging Req.
11
17
Regis.
22
TAU
Regis. Conf. [VLR TMSI]
TAU Conf.
26
20
MT

FIG. 5

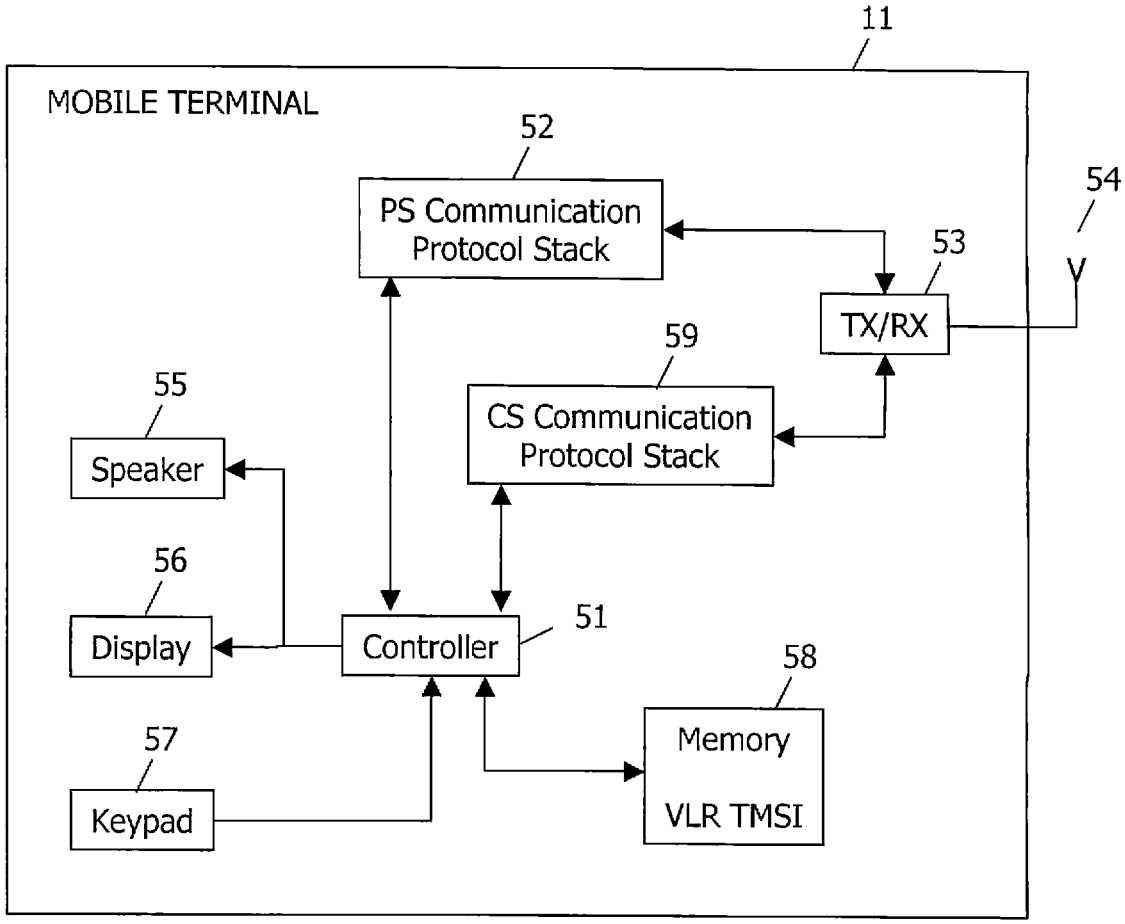
11
MOBILE TERMINAL
52
PS Communication Protocol Stack
54
53
TX/RX
59
CS Communication Protocol Stack
55
Speaker
56
Display
Controller
51
58
Memory
VLR TMSI
57
Keypad

FIG. 6

NETWORK NODE, METHOD, AND MOBILE TERMINAL FOR PROVIDING VOICE CALLS TO A MOBILE TERMINAL IN A PACKET-SWITCHED-ONLY NETWORK

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of co-pending U.S. patent application Ser. No. 11/428,103 filed on Jun. 30, 2006, the disclosure of which is fully incorporated herein by reference.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

REFERENCE TO SEQUENCE LISTING, A TABLE, OR A COMPUTER PROGRAM LISTING COMPACT DISC APPENDIX

Not Applicable

BACKGROUND OF THE INVENTION

This invention relates to communication systems. More particularly, and not by way of limitation, the invention is directed to a network node, method, and mobile terminal for providing voice calls to a mobile terminal operating in a packet-switched-only network.

Wireless networks today, such as second-generation (2G) GSM networks, third-generation (3G) networks, and Wireless Local Area Networks (WLANs) support Packet-Switched (PS) services and/or Circuit-Switched (CS) services. A user in a 2G or 3G network may use either CS services such as speech, or PS services such as Internet Access. The availability of CS and PS services also depends on the terminal. Some devices such as Laptop PC-cards are PS-only devices, while other devices such as older GSM phones without GPRS support are CS-only devices. A user in a PS-only network may use only PS services, although Voice-over-IP (VoIP) is emerging. New wireless networks such as Wimax support only PS and not CS. New standards for PS-only networks are also being investigated by the Third Generation Partnership Project (3GPP) in a feasibility study for System Architecture Evolution/Long Term Evolution (SAE/LTE). The SAE portion of this study is focused on a new core network, while the LTE portion of the study is focused on a new radio network.

General information regarding 2G and 3G networks may be found in the technical specification 3GPP TS 23.060, v.6.13.0. Further information about the Gs interface may be found in the technical specification 3GPP TS 29.018, v. 6.4.0. Further information about SAE/LTE networks may be found in the technical specification 3GPP TS 23.882, v. 1.2.3. Each of these technical specifications is hereby incorporated herein by reference.

Many users, however, prefer CS voice service because the quality of CS voice service is in many cases superior to PS voice quality. Operators may also prefer CS voice services because operators must heavily invest to provide VoIP services.

Some existing networks contain both a CS part and a PS part of the network. An interface known as the Gs interface provides co-ordination between a Mobile Switching Center/Visitor Location Register (MSC/VLR), which handles CS traffic in the CS part of the network, and a Serving GPRS Service Node (SGSN), which handles PS traffic in the PS part of the network. The Gs interface is used by the MSC/VLR for paging the mobile terminal for CS services, for exchanging location information between the CS part and the PS part, and for conveying some CS-related procedures through the SGSN. The Gs interface makes it possible for a mobile terminal supporting both CS and PS services to connect to both services via the PS domain. The Gs interface enables a mobile terminal using a combined CS and PS network to send some messages only to the PS part to save radio transmissions. The PS part then informs the CS part of needed information through signaling to ensure that both the CS and PS parts of the network have the same information about the mobile terminal.

When a mobile terminal is operating in a PS-only network, there are several reasons why the mobile terminal cannot receive CS voice calls. First, there is no mechanism for registering the mobile terminal with an MSC. Second, even if the mobile terminal was registered with an MSC/VLR, there is no signaling mechanism for forwarding paging messages from the MSC/VLR to the mobile terminal. Thus, the mobile terminal cannot be alerted when a CS voice call is incoming. Additionally, the mobile terminal itself lacks the functionality for using more than one radio technology at the same time. Although some high-end mobile terminals are capable of supporting more than one network technology, they cannot use more than one radio technology at the same time because battery consumption or interference issues make it technically impossible. Low-end terminals, where cost is an important issue, are often not designed with this capability due to cost constraints. Thus, the terminal is restricted to using either PS-only data services or CS-only voice services, but not both at the same time. Therefore, if the mobile user is using a PS-only data service, the user cannot receive any CS voice calls.

It should also be noted that networks providing both CS and PS services (such as GSM or WCDMA), generally have better coverage than PS-only networks (such as WLAN). However, PS-only networks generally offer higher bandwidths, perhaps even 100 times higher, than networks providing both CS and PS services. This higher bandwidth can be very useful for applications such as IPTV, video, downloading from the Internet, and the like. When a mobile terminal is using a PS service in a PS-only network, it is technically feasible to maintain the PS service when moving to a combined CS/PS network, if the two networks are operated by the same operator, and if the operator has chosen to implement the network in this way. In the combined CS/PS network, the same radio access technology is utilized for both CS and PS services, and the mobile terminal can receive CS voice calls while running the PS service. However, in most cases, some PS bandwidth capability will be lost. From the bandwidth perspective, it would be beneficial for the terminal to continue to use the PS-only network, but the drawback is that any incoming CS calls to the mobile terminal are lost.

What is needed in the art is a network node, method, and mobile terminal for providing voice calls to a mobile terminal that overcomes the disadvantages of the prior art. The present invention provides such a network node, method, and mobile terminal.

BRIEF SUMMARY OF THE INVENTION

The present invention is a network node, method, and mobile terminal for providing voice calls to a mobile terminal operating in a packet-switched-only network. From the user's

perspective, the invention provides the advantage that it enables a mobile terminal to receive CS voice calls when using a PS-only network. From the network operator's perspective, the invention enables the network operator to provide CS voice calls when the mobile users are using PS-only networks. The operator can therefore provide PS-only network services without having to fully implement VoIP services.

In one aspect, the present invention is directed to a method of providing a circuit-switched voice call to a mobile terminal operating in a packet-switched-only network. The method includes mimicking, in a control node in the packet-switched-only network, the messaging functionality of a Serving GPRS Service Node (SGSN); connecting the control node to a mobile switching center/visitor location register (MSC/VLR) in a circuit-switched network through a Gs interface; and forwarding by the control node, a paging message received from the MSC/VLR. The paging message is forwarded to the mobile terminal for direct response to the MSC/VLR.

In another aspect, the present invention is directed to a control node in a packet-switched-only network. The control node includes a packet-switched-only communication unit for wirelessly communicating with a mobile terminal; a SGSN mimic unit for mimicking the messaging functionality of an SGSN; and a Gs interface connection from the SGSN mimic unit to an MSC/VLR in a circuit-switched network.

In another aspect, the present invention is directed to a mobile terminal for receiving a CS voice call while operating in a PS-only network. The mobile terminal includes a packet-switched communication protocol stack for sending and receiving messages with a control node in the PS-only network; a circuit-switched communication protocol stack for sending and receiving messages with an MSC/VLR in a CS network; and a controller for determining when to use the packet-switched communication protocol stack and when to use the circuit-switched communication protocol stack.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

In the following, the essential features of the invention will be described in detail by showing preferred embodiments, with reference to the attached figures in which:

FIG. **1** is a signaling diagram illustrating the flow of messages between various network entities when a mobile terminal registers with a PS-only network in an exemplary embodiment of the system and method of the present invention;

FIG. **2** is a signaling diagram illustrating the flow of messages between various network entities when a mobile terminal performs a Tracking Area Update with a PS-only network in an exemplary embodiment of the system and method of the present invention;

FIG. **3** is a signaling diagram illustrating the flow of messages between various network entities when a mobile terminal receives a CS voice call while operating in a PS-only network in an exemplary embodiment of the system and method of the present invention;

FIG. **4** is a signaling diagram illustrating the flow of messages between various network entities when a mobile terminal receives a CS voice call while actively involved in data transmission in a PS-only network in an exemplary embodiment of the system and method of the present invention;

FIG. **5** is a simplified block diagram of an exemplary embodiment of a PS network node as taught by the present invention; and

FIG. **6** is a simplified block diagram of an exemplary embodiment of a mobile terminal as taught by the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention enables a mobile terminal to receive CS voice calls when operating in a PS-only network. This feature is enabled by adding to one or several nodes in the PS-only network, the functionality to act as an SGSN towards a combined CS/PS network with both CS and PS functionality, such as 2G or 3G networks. One or several nodes in the PS-only network then function as an SGSN proxy towards the combined CS/PS network, while requiring minimal or no changes in the combined CS/PS network.

FIG. **1** is a signaling diagram illustrating the flow of messages between various network entities when a mobile terminal (MT) **11** registers with a PS-only network in an exemplary embodiment of the system and method of the present invention. It is assumed that the MT is capable of utilizing a combined PS/CS network (such as a 3G network), and is also capable of utilizing a different PS-only network (such as, for example, an SAE/LTE network). However, the MT is not able to use both networks at the same time. The MT communicates with an SAE/LTE Evolved Packet Core (EPC) node **12** over a PS-only Evolved Radio Access Network (RAN) **13**. The term EPC denotes the Core Network and the included nodes needed for SAE. The EPC node, in turn, communicates with a Mobile Switching Center/Visitor Location Center (MSC/VLR) **14** in the combined PS/CS network over the Gs Interface **15**. To communicate directly with the MSC/VLR, the MT utilizes a combined (2G or 3G) RAN **16**.

At step **17**, the MT **11** sends a registration message including authentication information to the EPC node **12**. The MT may also include certain parameters, which enable the EPC node to mimic an SGSN. In a typical 2G/3G network registration, the MT would register with an SGSN by sending a combined GPRS and IMSI Attach message to the SGSN. Therefore, to enable the EPC node to mimic or emulate an SGSN, the MT may send the same parameters normally included in the GPRS and IMSI Attach message.

At step **18**, the EPC node **12** utilizes the Gs Interface **15** to send a Location Update Request message to the MSC/VLR **14**. Included in the message are parameters enabling the EPC node to mimic or emulate an SGSN. At step **19**, the MSC/VLR sends a Location Update Accept message to the EPC node. This message acknowledges the Location Update Request and includes a temporary identifier (e.g., VLR TMSI) for the MT. At step **20**, the EPC node sends a Registration Confirm message to the MT. This message acknowledges the Registration message **17** and includes several parameters including the VLR TMSI received from the MSC/VLR. The MT stores the VLR TMSI, which is needed for communications with the MSC/VLR.

FIG. **2** is a signaling diagram illustrating the flow of messages between various network entities when a mobile terminal performs a Tracking Area Update with a PS-only network in an exemplary embodiment of the system and method of the present invention. If the MT **11** changes Tracking Areas in the PS-only network, the MT reports this fact in a Tracking Area Update (TAU) message **22**, which is sent to the EPC node **12**. The change of Tracking Areas may or may not equate to a change of Location Areas in the 2G or 3G network. In 2G networks such as GSM, MTs are tracked in Location Areas (LAs) and Routing Areas (RAs). In UMTS (3G) networks, MTs may be tracked in UTRAN Registration Areas (URAs) as well as LAs and RAs. The term "Tracking Area" is used as

a generic name for URAs, LAs, and RAs. The EPC node is programmed with information for translating Tracking Areas into the equivalent Location Areas (for example, a TA/LA lookup table), and at step **23**, the EPC node determines whether the Location Area has also changed. If the Location Area has changed, the MSC/CLR **14** must be informed. Therefore, at step **24**, the EPC node utilizes the Gs Interface **15** to send a Location Update Request message to the MSC/VLR. Included in this message are the parameters necessary to mimic an SGSN. At step **25**, the MSC/VLR sends a Location Update Accept message back to the EPC node. At step **26**, the EPC node sends a TAU Confirm message back to the MT. Note that this message is sent to acknowledge the TAU message **22** regardless of whether the Location Area was changed.

FIG. **3** is a signaling diagram illustrating the flow of messages between various network entities when a mobile terminal receives a CS voice call while operating in a PS-only network in an exemplary embodiment of the system and method of the present invention. Steps **17** through **20** illustrate the registration process as described above in connection with FIG. **1**. At step **30**, the MSC/VLR **14** receives an incoming CS call for the MT **11**. At step **31**, the MSC/VLR utilizes the Gs interface **15** to send a Page message to the EPC node **12** identifying the MT. At step **32**, the EPC node sends the equivalent of a Paging Request message to the MT. Alternatively, this message may be an end-user message notifying the end user to manually initiate the change of radio network usage from the PS-only SAE/LTE network to the 2G/3G network. At step **33**, the MT performs the procedures to switch from the PS-only SAE/LTE network to the 2G/3G network. At step **34**, the MT sends a Paging Response message directly to the MSC/VLR. Thereafter, at step **35**, normal CS call setup procedures are performed between the MT and the MSC/VLR to accept and receive the incoming CS call.

It should be understood that the Paging Request message, which the MT recognizes as a CS-related message, is different from the PS-related message that the EPC node uses to invite the MT to participate in a PS data session. The MT recognizes the difference and sends the response to either the MSC/VLR or the EPC node accordingly.

FIG. **4** is a signaling diagram illustrating the flow of messages between various network entities when a mobile terminal receives a CS voice call while actively involved in data transmission in a PS-only network in an exemplary embodiment of the system and method of the present invention. Steps **17** through **20** illustrate the registration process as described above in connection with FIG. **1**. At step **29**, a PS session is established between the MT **11** and the EPC node **12**. If the MT **11** is actively involved in data transmission in a packet session in the PS-only network at the time the notification of an incoming CS voice call is received at step **30**, procedures may be utilized to also move the packet session from the PS-only network to the combined PS/CS network. As a result, the mobile end user is able to continue the packet session in the combined PS/CS network (although with less bandwidth), while also being able to receive the CS call. In one embodiment, when the MT receives the Paging Request message **32**, the MT answers by sending both a Page Response message **34** to the MSC/VLR **14**, and a Routing Area Update message **36** to its SGSN **37** to announce its presence in the 2G/3G PS network. Thereafter, at step **35**, normal CS call setup procedures are performed between the MT and the MSC/VLR to accept and receive the incoming CS call. Likewise, normal PS session establishment procedures **38** are performed between the MT and the SGSN to reestablish the data session in the 2G/3G PS network.

FIG. **5** is a simplified block diagram of an exemplary embodiment of a PS network node as taught by the present invention. In the illustrated embodiment, the network node is an EPC node **12** in an SAE/LTE network. Network nodes in other types of PS-only networks may also be utilized. The EPC node includes a PS-only communication unit **41**, which communicates with the MT **11** operating in the PS-only network. The PS-only communication unit receives and sends the various messages **17**, **20**, **22**, and **26** shown and described in FIGS. **1-4**. When the PS only communication unit receives the Registration message **17**, it authenticates the MT with an Authentication Unit **40**. The PS-only communication unit then forwards message parameters to an SGSN mimic unit **42** enabling the SGSN mimic unit to mimic SGSN signaling over the Gs interface **15** to the MSC/VLR **14**. In the illustrated example, the forwarded parameters are the parameters from a GPRS/IMSI Attach message. The SGSN mimic unit then sends the Location Update Request message **18** to the MSC/VLR **14**. The MSC/VLR returns the Location Update Accept message **19**, which as noted earlier, includes the VLR TMSI. The SGSN mimic unit forwards the VLR TMSI to the PS-only communication unit, which sends the VLR TMSI to the MT **11** in the Registration Confirm message **20**.

When the EPC node **12** receives a TAU message **22** from the MT **11**, the PS-only communication unit **41** forwards the TAU to a TA/LA lookup table **43**. The TA/LA lookup table determines whether the change of Tracking Area in the TAU message also resulted in a change of Location Area. If the Location Area did not change, the TA/LA lookup table reports this fact at **44** to the PS-only communication unit **41**, which sends the TAU confirm message **26** to the MT. If the change of Tracking Area also resulted in a change of Location Area, the TA/LA lookup table reports this fact at **45** to the SGSN mimic unit **42**. The SGSN mimic unit uses the Gs interface **15** to send the Location Update Request message **18** to the MSC/VLR **14**. The MSC/VLR returns the Location Update Accept message **19** to the EPC node, and any new VLR TMSI information is reported to the MT in the TAU Confirm message **26**.

When the MSC/VLR **14** receives a CS voice call for the MT **11**, the MSC/VLR sends the Page message **31** over the Gs interface **15** to the EPC node **12**. The Page message includes an identifier for the MT such as the MT's IMSI. The SGSN mimic unit **41** passes the Page to the PS-only communication unit **41**, which sends the Paging Request **32** to the MT. The MT then sends the Paging Response directly to the MSC/VLR **14**.

FIG. **6** is a simplified block diagram of an exemplary embodiment of a mobile terminal (MT) **11** as taught by the present invention. When the MT is operating in a PS-only network, a controller **51** controls a PS communication protocol stack **52**, which sends and receives messages **17**, **20**, **22**, and **26** through a transceiver (TX/RX) **53** and an antenna **54**. When there is an incoming CS voice call for the MT, the EPC node **12** may send an end-user message to the MT notifying the end user to manually initiate a change of radio network usage from the PS-only network to a 2G/3G network supporting CS calls. The controller may notify the user through a speaker **55** or a visual display **56**. The user may indicate the desire to accept the CS voice call through a keypad **57**. The controller then retrieves the VLR TMSI from memory **58** and causes a CS communication protocol stack **59** to construct and send the Paging Response **34** utilizing the transceiver **53** and the antenna **54**.

In an alternative embodiment, the MT is capable of automatically switching to the 2G/3G network. When the MT receives the Paging Request **32** indicating that there is an incoming CS voice call for the MT, the controller automati-

cally switches from the PS communication protocol stack **52** to the CS communication protocol stack **58** to construct and send the Paging Response **34** utilizing the transceiver **53** and the antenna **54**.

The controller **51** recognizes the Paging Request message as being a CS-related message, and thus uses the CS communication protocol stack **58** to send the Paging Response to the MSC/VLR **14**. The controller also recognizes when the EPC node **12** sends a PS-related invitation to participate in a PS data session. In this case, the controller uses the PS communication protocol stack **52** to send a response to the EPC node.

If the MT **11** is actively involved in data transmission in a packet session in the PS-only network at the time the notification of an incoming CS voice call is received, the procedures discussed above in connection with FIG. **4** may be utilized to also move the packet session from the PS-only network to the 2G/3G network. As a result, the mobile end user is able to continue the packet session in the combined PS/CS network (although with less bandwidth), while also being able to receive the CS call. When the MT receives the Paging Request message **32**, the controller retrieves the VLR TMSI from memory **58** and causes the CS communication protocol stack **59** to send a Page Response message **34** to the MSC/VLR **14**. The controller also sends a Routing Area Update message **36** to the MT's SGSN **37** to announce its presence in the 2G/3G PS network. Thereafter, normal CS call setup procedures are performed between the MT and the MSC/VLR to accept and receive the incoming CS call. Likewise, normal PS session establishment procedures are performed between the MT and the SGSN to reestablish the data session in the 2G/3G PS network.

Although preferred embodiments of the present invention have been illustrated in the accompanying drawings and described in the foregoing Detailed Description, it is understood that the invention is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications, and substitutions without departing from the scope of the invention. The specification contemplates any all modifications that fall within the scope of the invention defined by the following claims.

What is claimed is:

1. A method of providing a circuit-switched (CS) voice call to a mobile terminal operating in a packet-switched-only System Architecture Evolution/Long Term Evolution (SAE/LTE) network, said method comprising:

in a control node in the SAE/LTE network, emulating the messaging functionality of a Serving GPRS Service Node (SGSN);

connecting the control node in the SAE/LTE network to a mobile switching center/visitor location register (MSC/VLR) in a CS network through an interface;

receiving by the control node, a Paging Request from the MSC/VLR utilizing the interface; and

sending an equivalent of a CS paging request message from the control node to the mobile terminal in the SAE/LTE network, the equivalent of the CS paging request message indicating the MSC/VLR has received an incoming CS voice call for the mobile terminal, wherein the equivalent of the CS paging request message causes the mobile terminal to send a CS paging response directly to the MSC/VLR.

2. The method according to claim **1**, further comprising, after the connecting step, the steps of:

registering the mobile terminal with the MSC/VLR by sending a first message from the control node in the SAE/LTE network to the MSC/VLR, said first message including parameters that mimic parameters sent by a Serving GPRS Service Node (SGSN);

receiving by the control node via the interface, an identifier for the MSC/VLR; and

forwarding the identifier for the MSC/VLR to the mobile terminal.

3. The method according to claim **2**, further comprising:

receiving by the control node in the SAE/LTE network, a request from the SAE/LTE network to establish a data session with the mobile terminal; and

forwarding the request to the mobile terminal for direct response to the control node.

4. The method according to claim **1**, further comprising:

performing CS call setup procedures in the CS network to set up the CS voice call with the mobile terminal.

5. The method according to claim **1**, wherein the MSC/VLR is in a combined CS/PS network that also includes an SGSN, and the mobile terminal is actively involved in a PS data session in the SAE/LTE network when the equivalent of the CS paging request message is received from the control node, said method further comprising:

sending a paging response message from the mobile terminal to the MSC/VLR;

performing CS call setup procedures in the combined CS/PS network to set up the CS voice call with the mobile terminal;

sending a routing area update message from the mobile terminal to the SGSN, said routing area update message announcing the mobile terminal's presence in the combined CS/PS network; and

performing PS session establishment procedures in the combined CS/PS network to reestablish the PS data session with the mobile terminal.

6. The method according to claim **2**, further comprising:

receiving by the control node in the SAE/LTE network, a tracking area update message from the mobile terminal, the tracking area update message indicating that the mobile terminal has changed tracking areas in the SAE/LTE network;

determining by the control node in the SAE/LTE network, whether the mobile terminal has also changed location areas associated with the CS network; and

if the mobile terminal has also changed location areas:

sending a location update message from the control node in the SAE/LTE network to the MSC/VLR; and

sending a confirmation message from the control node in the SAE/LTE network to the mobile terminal; and

if the mobile terminal has not changed location areas, sending the confirmation message from the control node in the SAE/LTE network to the mobile terminal.

7. A control node in a System Architecture Evolution/Long Term Evolution (SAE/LTE) network, comprising:

an SAE/LTE communication unit that wirelessly communicates with a mobile terminal operating in the SAE/LTE network;

a Serving GPRS Service Node (SGSN) emulation unit that emulates the messaging functionality of an SGSN; and

an interface connection from the SGSN emulation unit to a mobile switching center/visitor location register (MSC/VLR) in a circuit-switched (CS) network;

wherein the control node receives a Paging Request from the MSC/VLR utilizing the interface connection, and the SAE/LTE communication unit sends an equivalent of a CS paging request message from the control node to the mobile terminal in the SAE/LTE network, the equivalent of the CS paging request message indicating the MSC/VLR has received an incoming CS voice call

for the mobile terminal, wherein the equivalent of the CS paging request message causes the mobile terminal to send a CS paging response directly to the MSC/VLR.

8. The control node according to claim **7**, wherein:

the SAE/LTE communication unit and the SGSN emulation unit forward registration information from the mobile terminal to the MSC/VLR, and forward an identifier for the MSC/VLR to the mobile terminal.

9. The control node according to claim **7**, further comprising:

a signaling unit that receives a request from the SAE/LTE network to establish a data session with the mobile terminal;

wherein the SAE/LTE communication unit forwards the request to the mobile terminal for direct response to the control node.

10. The control node according to claim **7**, wherein the control node in the SAE/LTE network receives a tracking area update message from the mobile terminal, the tracking area update message indicating that the mobile terminal has changed tracking areas in the SAE/LTE network, and the control node further comprises:

a comparing unit that determines whether the mobile terminal has also changed location areas associated with the CS network;

wherein, if the mobile terminal has also changed location areas, the control node in the SAE/LTE network sends a location update message to the MSC/VLR; and

wherein, if the mobile terminal has not changed location areas, the control node in the SAE/LTE network sends a confirmation message to the mobile terminal.

11. A mobile terminal for receiving a circuit-switched (CS) voice call while operating in a packet-switched-only System Architecture Evolution/Long Term Evolution (SAE/LTE) network, said mobile terminal comprising:

a packet-switched communication protocol stack that sends and receives messages with a control node in the SAE/LTE network, wherein the control node emulates the messaging functionality of a Serving GPRS Service Node (SGSN) and is connected by an interface connection to a mobile switching center/visitor location register (MSC/VLR) in a CS network;

a circuit-switched communication protocol stack that sends and receives messages with the MSC/VLR in the CS network; and

a controller that determines when to use the packet-switched communication protocol stack and when to use the circuit-switched communication protocol stack, wherein:

the controller determines whether a paging request message received from the SAE/LTE network is an invitation to participate in a data session in the SAE/LTE network, or is an invitation to accept an incoming CS voice call;

wherein the controller utilizes the packet-switched communication protocol stack to send a response to a control node in the SAE/LTE network upon determining that the paging message is an invitation to participate in a data session in the SAE/LTE network; and

wherein the controller utilizes the circuit-switched communication protocol stack to send a response directly to the MSC/VLR upon determining that the paging message is an invitation to accept an incoming CS voice call.

12. The mobile terminal according to claim **11**, wherein the paging request message is an invitation to accept an incoming CS voice call, and in response, the controller performs CS call setup procedures with the CS network to set up the CS voice call.

13. The mobile terminal according to claim **11**, wherein the MSC/VLR is in a combined CS/PS network that also includes a Serving GPRS Service Node (SGSN), and the mobile terminal is actively involved in a PS data session in the SAE/LTE network when a paging request message is received inviting the mobile terminal to accept an incoming CS voice call, wherein:

the controller performs CS call setup procedures in the combined CS/PS network to set up the CS voice call;

the controller sends a routing area update message from the mobile terminal to the SGSN, the routing area update message announcing the mobile terminal's presence in the combined CS/PS network; and

the controller performs PS session establishment procedures in the combined CS/PS network to reestablish the PS data session.

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